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FOOD OF COBIA, *RACHYCENTRON CANADUM*, FROM THE NORTHCENTRAL GULF OF MEXICO

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ABSTRACT The stomach contents of 403 cobia, *Rachycentron canadum*, caught in the northcentral Gulf of Mexico recreational fishery from April through October of 1987-1990 were examined. Cobia ranged from 373-1,530 mm in fork length. Of the 403 stomachs, 287 (71.2%) contained at least one identifiable prey taxon. Crustaceans, consisting primarily of portunid crabs, were the predominant food. Crustaceans occurred in 79.1% of the stomachs and comprised 77.6% of the total number of identifiable prey. The second most important prey category was fish which was dominated by hardhead catfish, *Arius felis*, and eels. Fish occurred in 58.5% of the stomachs but only accounted for 20.3% of the total number of prey. The importance of fish as prey increased with increasing size (length) of cobia, with the largest size class of cobia (1,150-1,530 mm FL) showing the highest percent frequency occurrence of fish prey (84.4%). There were no significant differences between the diets of male and female cobia. Species composition of the diet indicated that cobia examined in this study were generalist carnivores in their feeding habits and fed primarily on benthic/epibenthic crustaceans and fishes. However, the occurrence of pelagic prey provided evidence of diversity in the foraging behavior of cobia. Feeding in cobia indicated their dependence upon prey availability rather than upon a few specific food organisms.

Introduction

Rachycentron canadum, commonly known as cobia or ling, is a widely distributed, pelagic fish which occurs worldwide in tropical, subtropical, and warm temperate seas, except in the central and eastern Pacific Ocean (Shaffer and Nakamura 1989). In the western Atlantic, the cobia occurs from Massachusetts to Argentina (Briggs 1958), but is most common in the Gulf of Mexico (Migdalski and Fichter 1983), where it supports an important recreational fishery. In the Gulf of Mexico (Gulf) cobia range from Key West, Florida along the coast to Campeche, Mexico (Dawson 1971). Cobia typically migrate during spring and summer from their wintering grounds off southern Florida to spawning/feeding grounds in the northern Gulf and return to their wintering grounds in late fall and early winter (Biesiot et al. 1994, Franks et al. 1991).

The diet of *R. canadum* from the Gulf of Mexico, particularly the northern Gulf, is poorly known. Most of the previous research on the feeding habits of cobia was limited to simple descriptions of prey items found in a few stomachs. Miles (1949) reported the stomach contents of 11 cobia from Aransas Bay, Texas, and Knapp (1949, 1951) noted the prey found in 24 cobia taken from the same area. Reid (1954), Boschung (1957), and Christmas et al. (1974) commented on feeding in a small number of cobia from Cedar Key, Florida (one fish), coastal Alabama (four fish) and offshore Mississippi (eleven fish), respectively. These researchers found that crustaceans and fish made up the diet of *R. canadum*, although their conclusions varied on the relative importance of each prey type.

Knowledge of the food habits of cobia is necessary for understanding the role of diet in their growth and survival and for comprehending the dynamics of the fishery. The purpose of this study was to describe the diet of cobia from the northcentral Gulf of Mexico.

Materials and Methods

Cobia examined in this study were caught by hook-and-line in the northcentral Gulf recreational fishery from April through October of 1987-1990. Cobia were taken off southeast Louisiana, Mississippi, Alabama, and northwest Florida between lat. 30°25.0'-29°0.0'N and long. 86°0.0'-89°0.0'W. The majority of specimens were taken off coastal Mississippi. Some fish were provided by state and federal fisheries agencies.

Fish were well-iced from the time of capture until stomachs were removed at fishing docks or coastal fishing tournaments. Fork length (FL) was measured in mm and the sex was recorded. Most stomachs were placed in sealable plastic bags and stored in an ice slurry for short-term storage, usually 4-6 h. Stomachs were then either frozen or placed in 10% buffered formalin for later examination. Occasionally, when time permitted, stomachs were removed from fish, opened, and processed in the field.

Stomachs were thawed or removed from formalin, opened, and scored as either containing food or empty. Stomach contents were gently rinsed with fresh water into a 0.5 mm mesh sieve. Prey items were separated, identified to the lowest possible taxon, and counted. Accurate identification and counts could be made in most cases since foods were generally swallowed whole. Some prey items were in advanced stages of digestion and could not be identified to species; however, those prey were often identifiable to the family or order level.

Analyses

All analyses were based on stomachs containing at least one identifiable taxon. Prey too far digested for identification were not used in any computations. Additionally, some items found in stomachs were excluded because they were probably ingested incidentally. Examples of these were tubes of *Chaetopterus* worms, fragments of bivalve and gastropod shells, *Sargassum* weed, and pieces of coral, wood, and leather. Parasitic nematodes and acanthocephalons which occurred in some of the stomachs were also not considered in the diet analyses.

Numeric abundance, frequency of occurrence and percent frequency of occurrence (%F) were tabulated for all identifiable prey. In addition, major prey categories (crustaceans, fish, and cephalopods) were analyzed for percent numeric abundance (%N) and percent frequency of occurrence.

Three different fork length size classes of cobia, small (373-945 mm), medium (950-1,145 mm), and large (1,150-1,530 mm), were selected based on natural breaks within the size frequency distribution, and the percent frequency of occurrence of major prey within each was compared. A contingency table analysis and post-hoc test (Freeman-Tukey transformation) for proportional data were used to determine significant differences (α=0.05) between classes for each major prey category (Zar 1984).

Major prey of male and female cobia were also compared. Since males tended to be smaller than females, only cobia within the size range 590-1,045 mm FL were selected. This range contained most of the males sampled and reduced the confounding effect of size. Tests for significant differences (α=0.05) were made using a Fisher exact test corrected for continuity.

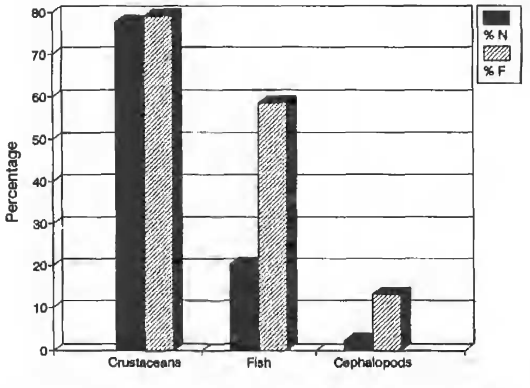

Figure 1. Percent numeric abundance (%N) and percent frequency of occurrence (%F) of major prey categories of *Rachycentron canadum* from the northcentral Gulf of Mexico.

RESULTS

The stomach contents of 403 *R. canadum*, ranging from 373-1,530 mm FL, were examined. Of these stomachs, 287 (71.2%) contained at least one identifiable prey taxon. Prey consisted of crustaceans, fishes, and cephalopods (Table 1). Another 35 (8.7%) stomachs contained only badly decomposed, unidentifiable remains. The remaining 81 stomachs (20.1%) were empty.

Invertebrates

Crustaceans were the primary food of cobia and, essentially, dominated the diet. Crustaceans occurred in 79.1% of the stomachs and ranked first (77.6%) in numeric importance among prey (Figure 1). Crustaceans were represented by eight families of decapods and two families of stomatopods (Table 1).

Portunid crabs were not only the predominant taxa among invertebrates consumed (Table 1) but also represented 60.7%N of total food items in the diet and occurred in 72.8% of the stomachs. The lesser blue crab, *Callinectes similis*, was the most abundant prey species found in the diet, comprising 36.5%N and occurring in 48.8% of the stomachs. The iridescent swimming crab, *Portunus gibbesii*, (12.5%N, 26.5%F) and the ladycrab, *Ovalipes floridanus*, (9.0%N, 23.3%F) were the next most important foods in the diet.

Following the portunids in importance were the sicyoniids and penaeids (combined=9.6%N). Other decapods, *i.e.*, callianassids, calappids, majids, pagurids and xanthids, occurred infrequently (Table 1). Stomatopods, predominantly Squillidae, comprised 6.9%N of the diet.

Cephalopods comprised the other primary invertebrate prey group and were represented by two families, Loliginidae, the predominant group, and Octopodidae. Cephalopods were found in 13.2% of the stomachs but only made up 2.2%N of prey consumed (Figure 1).

TABLE 1

Prey items occurring in stomachs of cobia, *Rachycentron canadum*, from the northcentral Gulf of Mexico, 1987-90. Percent frequency of occurrence based on *N*=287.

Prey	Total number of individual prey items	Frequency of occurrence	Percent frequency of occurrence
INVERTEBRATES			
Crustaceans			
Decapoda			
Penaeidae			
Penaeus aztecus	3	1	0.3
Penaeus setiferus	1	1	0.3
Penaeus sp.	34	8	2.8
Trachypenaeus sp.	37	9	3.1
Sicyoniidae			
Sicyonia brevirostris	62	15	5.2
Sicyonia sp.	102	18	6.3
Callianassidae			
Callichirus islagrande	1	1	0.3
Paguridae sp.	2	2	0.7
Calappidae			
Calappa flammea	2	1	0.3
Hepatus epheliticus	2	2	0.7
Majidae			
Libinia emarginata	1	1	0.3
Portunidae			
Arenaeus cribrarius	16	8	2.8
Callinectes sapidus	5	5	1.7
Callinectes similis	909	140	48.8
Ovalipes floridanus	224	67	23.3
Portunus gibbesii	312	76	26.5
Portunus sayi	1	1	0.3
Portunus spinicarpus	16	3	1.0
Portunus spinimanus	30	17	5.9
Xanthidae			
Menippe adina	1	1	0.3
Stomatopoda			
Lysiosquillidae			
Lysiosquilla scabricauda	2	2	0.7
Squillidae			
Squilla chydaea	2	2	0.7
Squilla empusa	78	21	7.3
Squilla neglecta	1	1	0.3
Squilla sp.	88	40	13.9
Cephalopods			
Loliginidae			
Loligo pealei	1	1	0.3
Unid. loliginids	47	33	11.5
Octopodidae			
Octopus sp.	6	4	1.4
FISH			
Squatinidae			
Squatina dumeril	1	1	0.3
Dasyatidae			
Dasyatis sp.	7	7	2.4
Torpedinidae			
Narcine brasiliensis	4	3	1.0
Anguilliformes	133	52	18.1

Prey	Total number of individual prey items	Frequency of occurrence	Percent frequency of occurrence
Clupeidae			
Brevoortia patronus	19	3	1.0
Brevoortia sp.	2	2	0.7
Unid. clupeids	4	4	1.4
Engraulidae			
Anchoa sp.	2	1	0.3
Unid. engraulid	1	1	0.3
Ariidae			
Arius felis	138	70	24.4
Ophidiidae	5	4	1.4
Ogcocephalidae			
Halieutichthys aculeatus	1	1	0.3
Syngnathidae	2	2	0.7
Triglidae			
Prionotus sp.	48	7	2.4
Serranidae			
Diplectrum bivitatum	33	2	0.7
Unid. serranids	2	1	0.3
Carangidae			
Decapterus punctatus	26	18	6.3
Seriola dumerili	1	1	0.3
Unid. carangid	1	1	0.3
Lutjanidae			
Lutjanus campechanus	3	3	1.0
Sparidae			
Lagodon rhomboides	10	10	3.5
Unid. sparid	1	1	0.3
Sciaenidae			
Menticirrhus sp.	3	3	1.0
Micropogonias undulatus	9	3	1.0
Cynoscion sp.	1	1	0.3
Leiostomus xanthurus	1	1	0.3
Mugilidae			
Mugil sp.	5	3	1.0
Uranoscopidae			
Astroscopus y-graecum	5	5	1.7
Trichiuridae			
Trichiurus lepturus	3	1	0.3
Stromateidae			
Peprilus burti	1	1	0.3
Peprilus sp.	3	1	0.3
Bothidae			
Citharichthys sp.	12	3	1.0
Etropus crossotus	1	1	0.3
Etropus sp.	2	1	0.3
Soleidae			
Symphurus plagiusa	1	1	0.3
Symphurus sp.	1	1	0.3
Balistidae			
Balistes capriscus	1	1	0.3
Unid. balistids	4	3	1.0
Tetraodontidae			
Chilomycterus schoepfi	2	2	0.7
Unid. tetraodontids	6	3	1.0
	Total 2,491		

Number of stomachs examined	403
Number (and %) of stomachs containing identifiable prey	287 (71.2)
Number (and %) of stomachs containing only decomposed, unidentifiable remains	35 (8.7)
Number (and %) of empty stomachs	81 (20.1)

Fish

Although contributing substantially to the diversity of the diet, fish were not as important as crustaceans. Fish occurred in 58.5% of the stomachs and accounted for 20.3%N of all prey consumed (Figure 1). A wide variety of fishes was consumed, including twenty families of bony fishes and three families of cartilaginous fishes (Table 1).

The hardhead catfish, *Arius felis*, and eels (Order Anguilliformes) were by far the predominant fishes in the diet. *Arius felis*, found in 24.4% of stomachs, exhibited the highest numeric percentage (27.3%) among fish and contributed 5.5%N to the total diet. Eels occurred in 18.1% of stomachs, comprised 26.3%N of fish in the diet, and accounted for 5.3%N of total items in the diet.

Fish less frequently encountered in the diet included round scad, *Decapterus punctatus* (Carangidae) and pinfish, *Lagodon rhomboides* (Sparidae). Other identified fish occurred only rarely (Table 1).

Comparison of diet among size classes of cobia

Crustaceans dominated the diet of the small (77.2%F) and medium (84.8%F) size classes of cobia, and made up a primary portion (65.6%F) of the large size class (Figure 2). Despite these high frequencies, contingency table analysis (χ^2=10.25, df=2, p<0.05) and the corresponding post-hoc tests indicated all three size classes were significantly different from each other. Portunid crabs, particularly *Callinectes similis*, were the most important prey consumed in all size classes of cobia (Table 2).

In contrast, the importance of fish as prey increased with increasing size of cobia, the largest size class showing the highest percent frequency of occurrence (84.4%) (Figure 2). The increase in fish occurrence was attributable to the hard-head catfish, *Arius felis*, which increased from 7.0%F in the small size class to 43.8%F in the large cobia (Table 2). Again, contingency table analysis (χ^2=27.77, df=2, p<0.001) and post-hoc tests indicated that all size classes were significantly different from each other.

The percentage of cephalopods (predominantly squid) remained consistently low across the three size classes (Figure 2, Table 2). No significant differences were found.

Comparison of the diets of male and female cobia

The diet of male and female cobia within the size range of 590-1,045 mm FL appeared to be similar (Table 3). Crustaceans were the dominant prey in both sexes. Although females showed a higher percent frequency of occurrence (86.8%) of crustaceans than did males (79.2%), these differences were not significant. Portunid crabs were the major component of crustaceans ingested by both sexes.

Fish occurred with greater frequency in the diet of males (60.4%F) than in the diet of females (46.2%F), partially due to a greater occurrence of eels in the male diet (Table 3). Males, however, fed less frequently on catfish. As with the crustacean prey, no significant differences were found between the diets of male and female cobia with respect to fish or cephalopod prey.

TABLE 2

Percent frequency of occurrence of major taxa in the stomachs of three size classes of *Rachycentron canadum* from the northcentral Gulf of Mexico.

Fork length (mm)	373-945	950-1145	1150-1530
	N=57	*N*=164	*N*=64
Crustaceans			
(Portunid crabs)	(63.2)	(80.5)	(64.1)
Callinectes similis	35.1	53.0	51.6
Portunus gibbesii	17.5	31.1	23.4
Ovalipes floridanus	19.3	28.0	15.6
Stomatopods	24.6	19.5	25.0
Fish			
Anguilliformes	14.0	19.5	18.8
Arius felis	7.0	22.0	43.8
Cephalopods			
Loliginidae	17.5	9.1	14.1

TABLE 3

Percent frequency of occurrence of major taxa from the stomachs of male and female *Rachycentron canadum* from the northcentral Gulf of Mexico. Size range from 590-1045 mm FL.

	Male	Female
	N=48	*N*=106
Crustaceans		
(All Crustaceans)	(79.2)	(86.8)
(Portunid crabs)	(70.8)	(80.2)
Callinectes similis	33.3	52.8
Portunus gibbesii	20.8	32.1
Ovalipes floridanus	16.7	30.2
Stomatopods	14.6	19.8
Fish		
(All Fish)	(60.4)	(46.2)
Anguilliformes	27.1	17.9
Arius felis	6.3	17.0
Cephalopods		
Loliginidae	10.4	14.2

DISCUSSION

We found crustaceans, primarily portunid crabs, to be the dominant foods of cobia both in terms of numeric abundance and percent frequency of occurrence. Fishes were second in order of importance. These results vary somewhat from the findings of other researchers. Miles (1949) reported crabs, shrimps, and fishes in near equal numbers in the stomachs of cobia taken from Aransas Bay, Texas, and, similarly, Christmas et al. (1974) found the numbers of fishes and crustaceans to be approximately the same in their samples from northern Gulf waters off Mississippi. In sharp contrast, Knapp (1951) observed a predominance of fishes (83.3%F), followed by stomatopods (58%F), penaeid shrimps (46%F) and crabs (42%F) in the diet of cobia caught near Aransas Bay, Texas. The conclusions reached in previous studies were based on examinations of a limited number (24 or less) of stomachs. Although cobia examined in our study were collected by hook-and-line and, therefore, did not represent a random sample, we believe our findings represent a more definitive description of the diet of cobia in the northern Gulf of Mexico, due, in part, to our high sample number (N=287) and extensive geographical range.

Although crustaceans were the dominant food, our results also indicated that larger cobia, males and females alike, consumed fish with significantly greater frequency than did smaller cobia. This may reflect an ontogenetic shift toward fish as prey in larger cobia. Our results, however, showed no significant differences in the diet of male and female cobia within a range of comparable sizes which may be attributable to the relatively low sample size of males. Although not statistically different, we did encounter fish more frequently in the stomachs of males than females which also may be an indication of an ontogenetic shift toward fish prey since most of the large males, and not the large females, were included in the male-female comparative analysis.

The species composition of the diet revealed that cobia fed primarily on or near the sea floor. The portunids, sicyoniids, penaeids, and stomatopods, though capable of swimming, are primarily benthic or epibenthic inhabitants. Octopi, as well as many of the fish prey (*e.g.*, bothids, uranoscopids, arrids, triglids, dasyatids, eels), also reside on or near the bottom. However, other prey such as carangids, clupeids, and squid are pelagic organisms, and their presence in the diet indicated flexibility in the foraging behavior of cobia.

In summary, we found that the primary foods of cobia from the northcentral Gulf of Mexico were benthic or epibenthic crustaceans and fishes, although some feeding did occur in the water column and nearsurface. Additionally, our results indicate that the cobia is an opportunistic carnivore and that feeding appears to depend more on prey availability rather than upon a few specific food organisms.

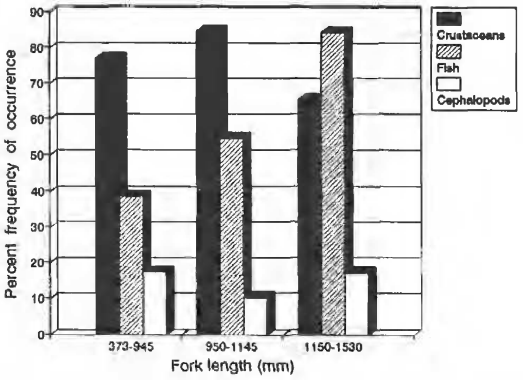

Figure 2. Percent frequency of occurrence of major prey categories for three size classes of *Rachycentron canadum* from the northcentral Gulf of Mexico.

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